Workshop Report

Dec 11th 2020
Jaarsymposium Circulaire Maakindustrie

Achieving circularity and supply chain resilience of critical raw materials (CRMs)

Energy Management & Circular Economy Team of KPN

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Executive summary

The workshop conducted by KPN on the 11th December 2020 at the Jaarsympiosium Circulaire Maakindustrie had a goal of exchanging knowledge on achieving circularity and supply chain resilience for Critical Raw Materials (CRMs). Participants of the workshop mainly came from Research & Development, Product Design, Product Manufacturing, Disassembly & Pre-Treatment, Smelting & Refining companies. Additionally, several participants from other industries joined the workshop as well. The following gives an overview of the most important results:

The main drivers for achieving circularity in CRMs include the goals toward sustainability, avoiding impacts associated with CRMs, supply chain resilience, the emergence of advanced technologies, regulations on circular resource use and competitive market advantage. The main barriers for hindering circularity of CRMs include a lack of skills, knowledge among the workforce, information, coordination among the value chain and advanced technologies, as well as shortage of economic drivers and difficulties in transforming existing business models.

Throughout the supply chain, there are different ways to enhance collaboration among partners to achieve circularity. The main findings include that emphasis should be put on the usage of waste as a source for secondary materials. Furthermore, products should already be designed for upgradeability or recycling (e.g. pay for performance, long lifetime of products, product as a service). In general, material and product passport should be implemented in order to enhance transparency. Potential solutions for creating this eco-mindset can be to provide engineers with facility tours and training about environmental and social impact associated with CRMs. Additionally, communication among stakeholders is key. Here, mainly a standardized/common language should be created. Regarding policy and regulations, it is proposed to incentivize circular options in products. Lastly, it is suggested for research and development to revolutionize waste separation techniques and develop electronics with non-critical materials.

When it comes to building a supply chain resilience, internal action points within an organization include the translation of goals into practice, keeping the topic at the board of management, providing investment possibilities to change internal policies, digitalizing the product lifecycle and thorough study and documentation of the topic. External action points between different parties include incorporating CRMs as part of supplier contracts, fostering partnerships along the value chain and promoting active communication about CRMs. On the system-level, subsidies to support the change, standardization of products, e-waste management, and diversification of the supply chain is stressed, together with education on the topic for future engineers.

Introduction of the workshop

Our economy heavily depends on raw materials for the manufacturing of products and components. Some of these raw materials are considered **critical**, since they are associated with high economic importance and supply risks.

Therefore, as part of the Jaarsymbiosium Circulaire Maakindustrie 2020, KPN engaged in presenting the corporate approach on the **Circularity** and **Supply Chain Resilience** of **Critical Raw Materials (CRMs)** as part of a keynote speech and in-depth workshop. The goal was to share our gained knowledge in the field and to show possible pathways to take in order to mitigate risks arising from CRMs.

The conducted workshop had the goal to engage partners along the value chain, as well as from research institutes to have a knowledge exchange with KPN on the following topics:

1. Drivers and barriers for the circularity of CRMs
2. Strategies on how to enhance collaboration among partners in the product value chain
3. Action points to build up supply chain resilience on an internal, external, and systemic level

A brainstorming session was conducted on a platform Miro, which entailed the results on the following slides.

Question 1

What are the drivers/barriers for you to work to achieve circularity of CRMs?

Drivers

Sustainability goals
- Organizational mission to improve sustainability
- Termination of waste generation
- UN SGDs, EU Circular Economy Goals, and Green Deals

Avoiding impacts associated with CRMs
- Environmental and social impacts
- Preventing depletion of finite resources

Supply chain resilience
- Reliable supply of CRMs for essential technologies
- Need for a study on CRMs substitutability

Advanced technology
- Digitization tools for product quality examination and repair
- Advanced recycling technology such as hydrometallurgy

Regulations on circular resource use
- Right to repair to increase circular design
- Regulations on high quality recycling accelerating technology and design

Competitive advantage in the market

Barriers

Lack of skills and knowledge among workforce
- Engineers not trained to incorporate the goal into the work

Limited availability of information
- Lack of transparency in CRMs supply chain
- Information from literatures broad and difficult to apply into certain designs
- Lack of knowledge on material substitutability
- Lack of understanding in material composition of products

Shortage of economic drivers
- Clients do not pay for CRMs circularity to contractors hired for product design - need for clients to invest in the process

Difficulty in transforming existing business model
- High cost for product redesign and value chain restructuring

Lack of coordination along the value chain
- Component/product miniaturization leading to less recyclability of CRMs

Complexity of printed circuit board
- Complexity grows while more function concentrated in chips

Recycling technology still in development

Question 2

How can we enhance collaboration among supply chain partners to achieve circularity of CRMs?

**Per value chain*

Material extraction & Sourcing

- Use of secondary resource
- Raising awareness among engineers on impacts of CRMs through e.g. facility tours

Product Design/ Development

- Eco-mindset
- Design for upgradability, recyclability, and circular economy
- Training possibilities for engineers
- Product passports

Component Manufacturer

- Use of secondary materials
- Increase use efficiency
- Material passports

Product Manufacturer (OEM)

- Right to repair
- Easier access to internal expert on the topic in large corporation
- Keeping the product ownership

Service provider

- Raising awareness among customers
- Drive collaborative R&D at the value chain
- Improve communication within companies
- Product as a Service
- Support changes to digitalization and smart industry

Smelter & Refinery

- Efficient CRM recovery
- End-of-life (EOL) mining

Question 2

How can we enhance collaboration among supply chain partners to achieve circularity of CRMs?

**Overarching influencing bodies*

Along the entire value chain

- Invite supply chain partners to engage in knowledge exchange
- Foster long-term relationships instead of short-term procurement contracts
- Create a standardized, common language among partners
- Pay for performance/lifetime of products, instead of components

Policy & Regulation

- Incentivize circular options

Research & Development

- Development of new waste separation techniques
- Development of electronic equipment based on non-critical materials

Question 3

Which actions need to be taken today in order to mitigate potential CRMs supply risks of your future technologies?

Internally

- **Translating the goal into practice:** Make information and training available for specific products
- **Incorporation from the top:** Keep sustainability goals close to the board of management and incorporate them into strategies
- **Investment for the change:** Apply for extra funding to change internal policy and way of working
- **Digitizing product lifecycle:** Digitize the product lifecycle management process to extend the lifetime of products
- **Study & documentation:** Understand strategic importance of CRMs and potential mitigation strategies via assessment. Documentation of CRMs used in products.

Externally

- **Make it part of the contract:** Include CRMs-related goal as part of the agreement
- **Partnership is the key:** Value of partnership proven to be crucial for supply chain - build solid trust and long-term relationship with the partners. Maintain long-term relationship with suppliers to keep repair components available. Make CPO a Chief Partnership Officer.
- **Communication about CRMs:** Inform clients about the CRMs from supplier’s level

At system-level

- **Diversification of supply chain:** Source materials from suppliers certified as more sustainable
- **Subsidies to support the change:** Make funding available to parties actively engaging with the goal
- **Standardization:** Develop industry standardization that complies with regulations and meet the goal
- **E-waste management:** Align the total chain of e-waste for more efficient CRMs recovery
- **Education to future engineers:** Educate engineering students about the circular economy and CRMs to encourage incorporating the mindset in their work.

Dec 11th 2020

Jaarsymposium Circulaire Maakindustrie

[Workshop]
Building a resilient supply chain for Critical Raw Materials (CRMs) in the telecommunication sector

Energy Management & Circular Economy Team of KPN

Yeji Park – Researcher Circularity for Critical Raw Materials

Gloria Flik – Researcher Critical Raw Materials for Future Technologies

Introduction

Gloria Flik

Critical Raw Materials for Future Technologies

Yeji Park

Circularity of Critical Raw Materials

Contents

I. Presentation

10:05 **Material Criticality for the core and future equipment**
Gloria Flik | Researcher Critical Raw Materials for future technologies

10:10 **Achieving a circular use of CRMs**
Yeji Park | Researcher Circularity of Critical Raw Materials

II. Workshop

10:15 **Brainstorming session on Miro**

10:35 **Discussion**

10:55 **Closing**

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What are critical raw materials (CRMs)?

As defined by the European Union [1]

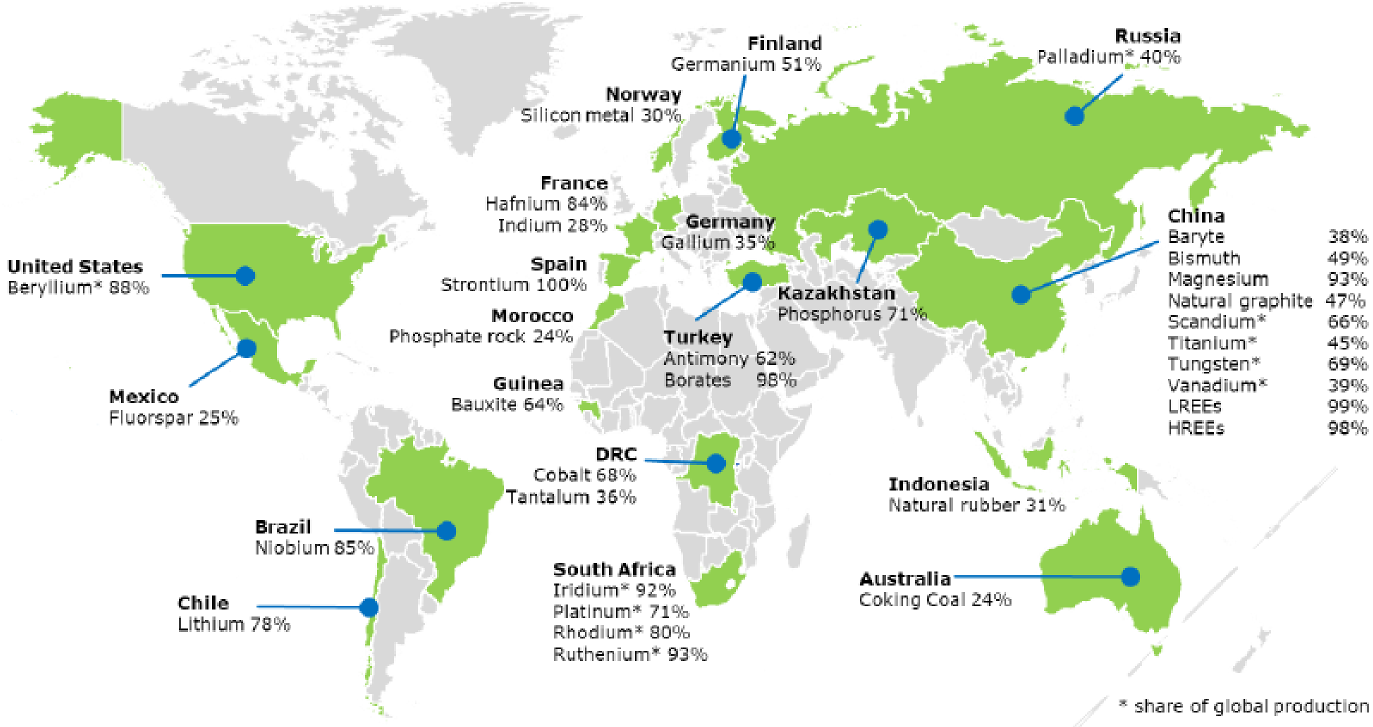
Biggest supplier countries of CRMs in the EU

Critical raw materials

- Economic importance
- Supply risk

Reasons for material criticality [3]:

- Scarcity Risk
- Geopolitical Risk
- Demand Risk
- Environmental Risk
- Supply Chain Risk
- Market Risk
- Social Risk



Source: European Commission report on the 2020 criticality assessment [2]

How to start?

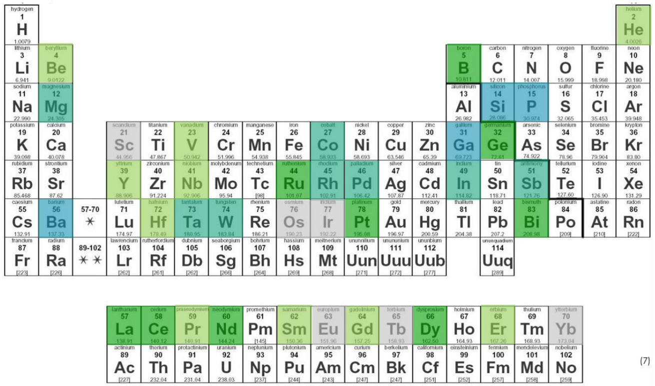
From the equipment to the mitigation strategy

Step 1
Identify Key Equipment

Step 2
Identifying Raw Material Content

Step 3
Conduct Criticality Assessment

Step 4
Determine Mitigation Strategies



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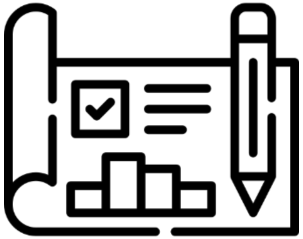
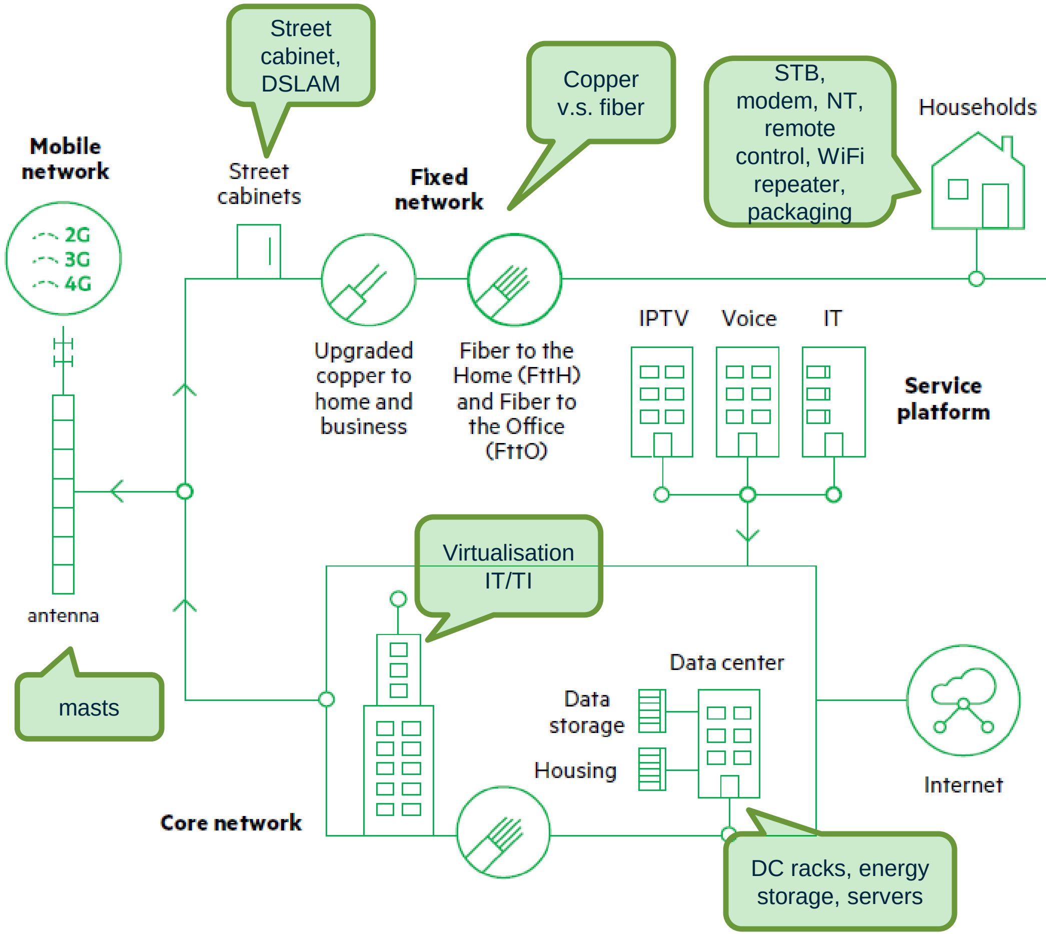
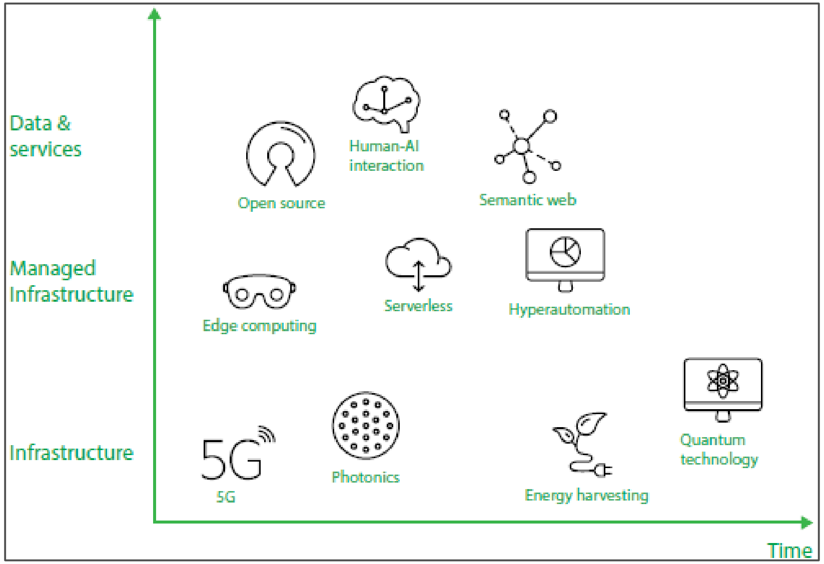


Step 1 + 2 : Identification of Core equipment & Raw Material Content

Close collaboration with suppliers necessary



Future Research – Strategic Importance



KPN Technology Book 2020

Step 3: Criticality Assessment

Dimensions

Criticality assessment domains

- Vulnerability to supply restriction
- Supply risk
- Environmental implications
- Social implications

Economic risk: Vulnerability to supply restriction, Supply risk

Reputational risk: Environmental implications, Social implications

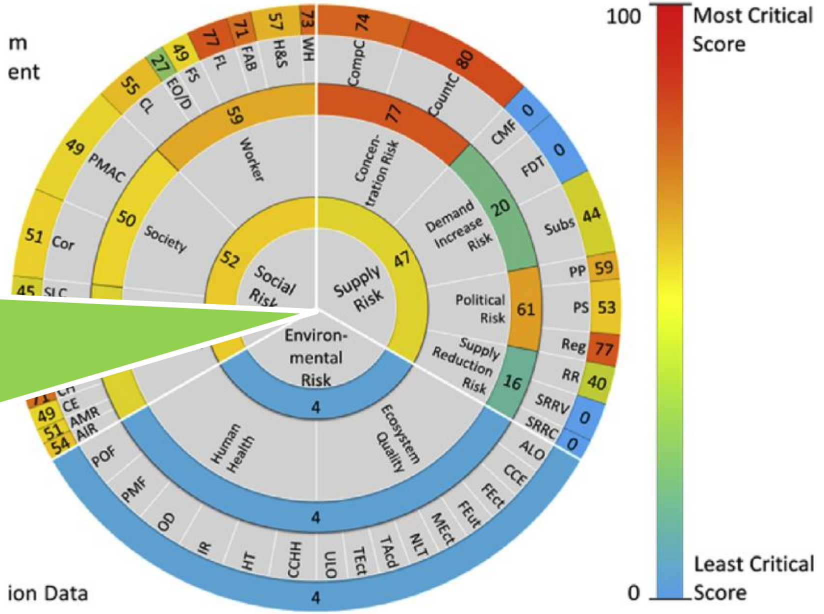
Which material should be prioritized?

Where may KPN encounter high risks?

?

[4]

Example of the Assessment of Aluminum (Kolotzek et al., 2018))



Step 3: Criticality Assessment

Examples based on literatures

1 Goal & Scope Definition

The system at risk → The objective of the assessment → Material focus

2 Quantified Risk

	Vulnerability to Supply Restrictions	Supply risk	Environmental implications	Social implications
	Potential damage from involuntarily reduced use of materials	Likelihood of supply disruption	Damage caused by raw material extraction and likelihood of emerging reputational risk	Social hotspots on the country level.
Example Indicators	Substitutability	Country concentration	Ecosystem Quality	Local Community
	Product value	Depletion time	Human Health	Society
	Future demand	Substitutability		Worker
	Strategic importance	Import dependence		
	Material value	Recyclability		
	Spread of utilization	Demand growth		

3 Source

Vulnerability to Supply Restrictions	Supply risk	Environmental implications	Social implications
Helbig et al. (2016) – How to evaluate raw material vulnerability – An Overview. **[5]**	Achzet et al. (2013) – How to evaluate raw material supply risk **[6]**	Graedl et al. (2011) – Methodology on Metal Criticality Determination **[7]**	Kolotzek et al. (2018) – A company-oriented model for assessment of raw material supply risks, environmental impacts and social implications **[4]**

Step 4: EU Critical materials in KPN products

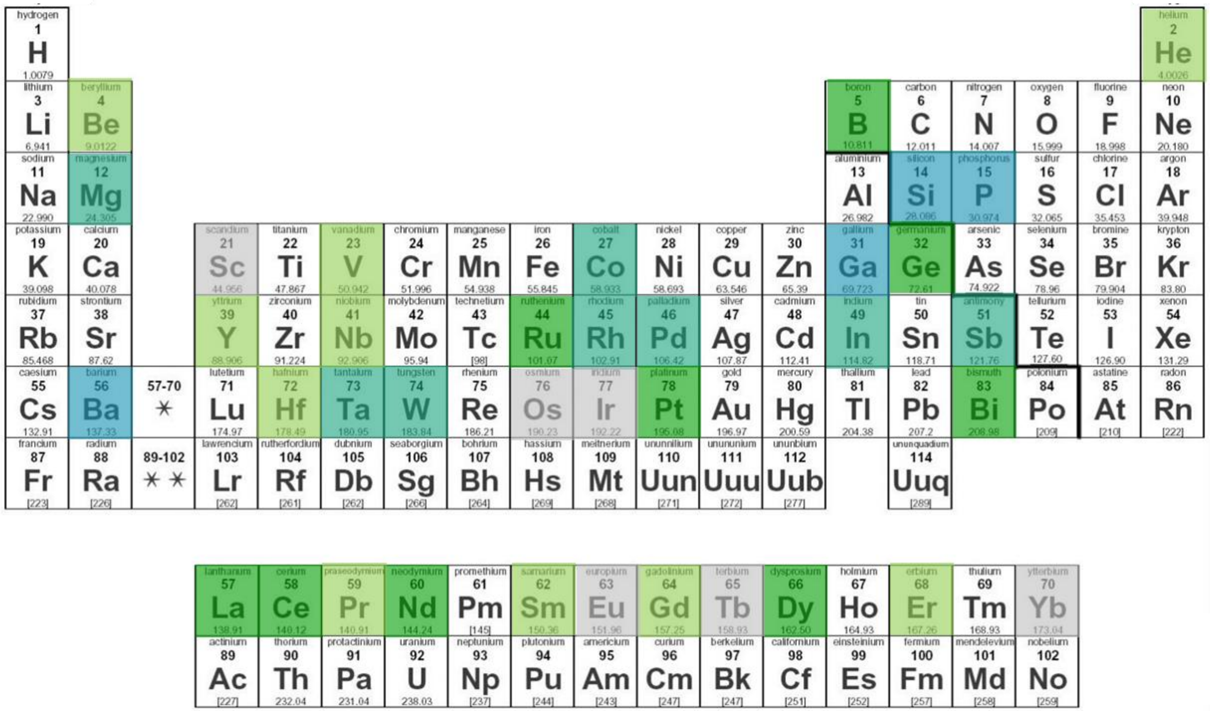
Occurence in KPN products

Data on 4 products

Number of products the material is contained in:

1	2	3	4

on EU list



Remote Control | **Modem** | **Core router** | **Blade Server**

Mitigation strategies

Example: Rhodium

Rhodium (Rh)

Function:
- Plating of electric contacts
- Constituent of capacitors and resistors

Hotspots

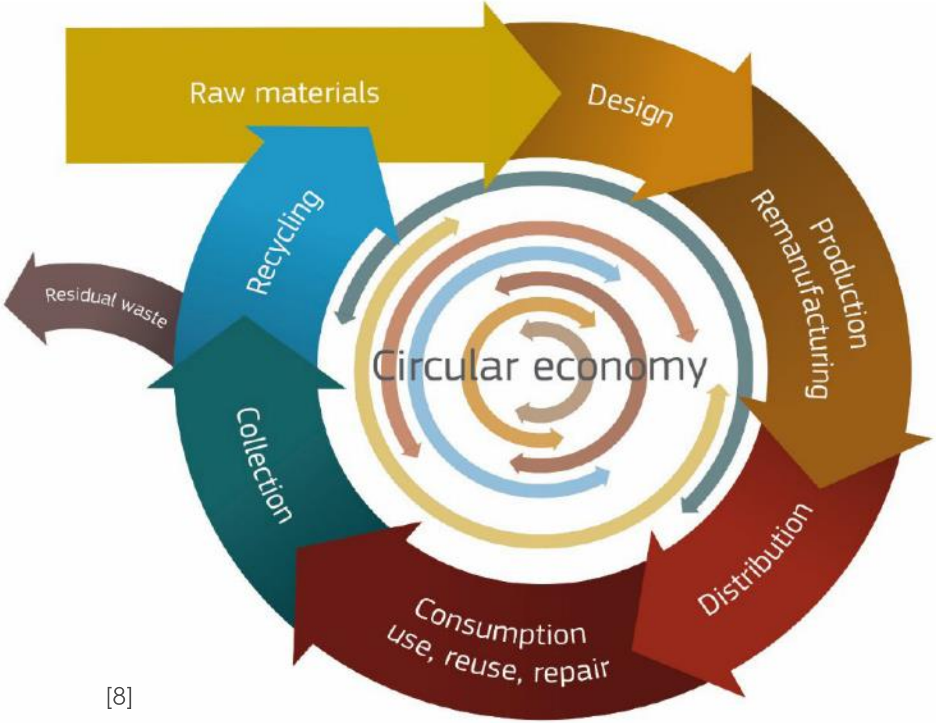
Companion metal, hardly substitutable
Political stability/regulations
80% South Africa

Mitigation strategy

Associated risk	Internal & External	Systemic
Economic risk	• Design for reuse/refurbishment/recyclability • Use secondary material source • Substitution to non-critical materials	• Demand-based recycling targets • Research subsidies and standardization • Trade agreements
Environmental risk Social risk	• Transparency • Due diligence on suppliers • Sourcing CERA (CErtification of RAw Materials) certified components/materials	• Translating externalities into pricing • Trade agreements incl. social and environmental conditions for goods

Achieving the circular use of CRMs

Expansion of CE application from mass material to CRMs



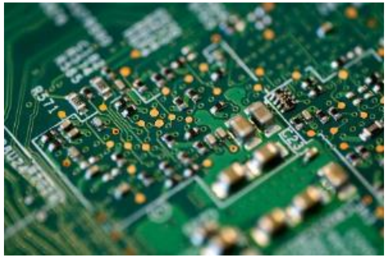
[8]

Mass materials

Plastic

Aluminium

Copper

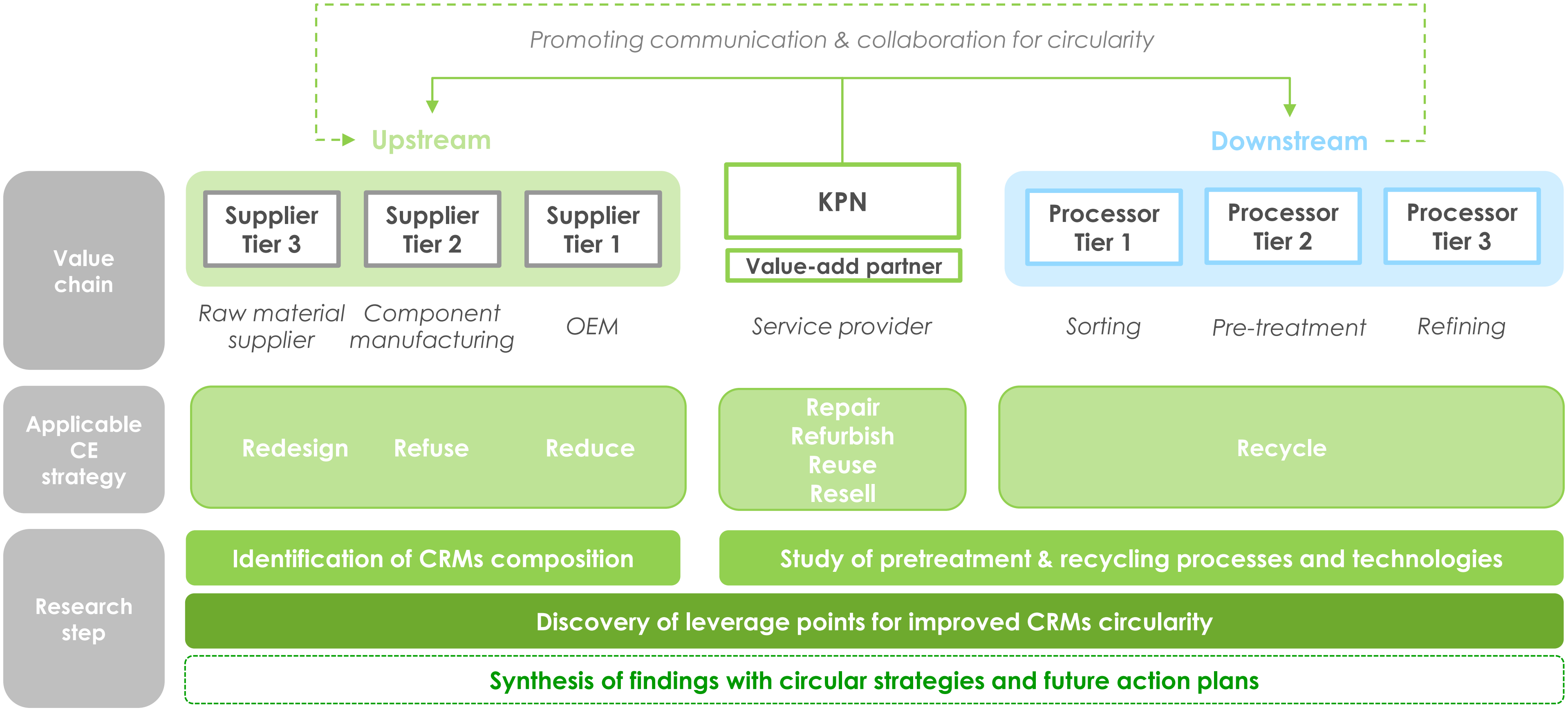


Printed Circuit Board (PCB) - *Component* - *CRM*

Critical raw materials

Improving the circularity of CRMs in KPN's equipment

Research plan and main concepts



Circular strategy for CRMs

Example of three CRMs commonly used in ICT device

Smartphone

Modem

46
Pd
Palladium
106.42

49
In
Indium
114.818

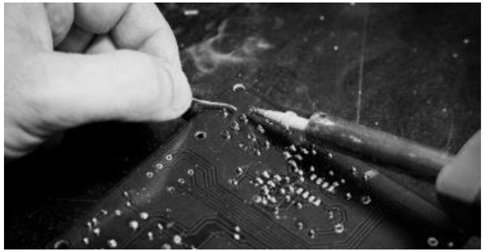
31
Ga
Gallium
69.723

Case example: Circular strategy for three CRMs

Product value chain of ICT equipment

Cradle to grave value chain

Materials production		Product development & production		Use			End of Life	
Raw material extraction	Material processing	Product design/development Component manufacturing	Product design/development Product manufacturing	Purchase/ Distribution	Use	Collect	Pre-treatment	Smelting



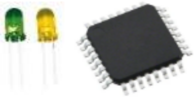
Case example: Circular strategy for three CRMs

Product value chain with specifications on CRM contents

Cradle to grave value chain

Materials production		Product development & production		Use			End of Life	
		Product design/development						
Raw material extraction	Material processing	Component manufacturing	Product manufacturing	Purchase/ Distribution	Use	Collect	Pre-treatment	Smelting

CRMs specifications

		Application	Concentration in WEEE [9]	EOL treatment (Recycling rate) [9]	
Pd		Capacitors, ICs, electrode, and etc.	30 – 200 ppm	Physical treatment	Pyrometallurgy (50%)
In		LCD panels, LEDs	0.05 – 1 %	Crushing & separation	Hydrometallurgy (<1%)
Ga		LEDs, ICs	2 – 140mg/kg(PCB)[10]	.	.

CRMs flow throughout product value chain

Case example of 3 CRMs

Cradle to grave value chain

- **Materials production**
  - Raw material extraction
  - Material processing
- **Product development & production**
  - Product design/development
  - Component manufacturing
  - Product manufacturing
- **Use**
  - Purchase/ Distribution
  - Use
  - Collect
- **End of Life**
  - Pre-treatment
  - Smelting

Applicable CE strategy | Leverage points

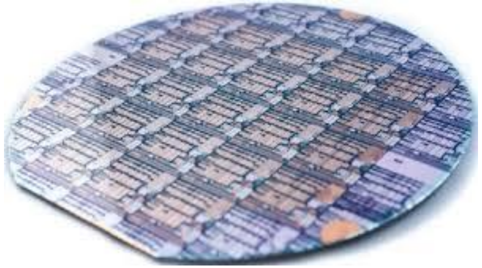
- **Use of secondary material**
  - Primary material cheaper than secondary
  - Economic incentive for use of secondary over primary material
- **Design for reuse/ refurbishment/ recyclability**
  - Difficulty in reaching layers of suppliers
  - Collaboration & communication among tiers of suppliers
- **Maintain**
- **Refurbish**
- **Reuse/ Resell**
  - Low collection rate
  - Take-back/ Product as service
  - Potential loss in logistics
  - SC management optimized for reuse/resell
- **Recycle**
  - CRM loss in pretreatment
  - Low concentration & economic value in WEEE fractions
  - Treatment optimized per CRM/WEEE via close communication among processors

CRMs application in other industries

CRMs circularity: crucial topic to a wide range of industries

Auto catalyst

LCD



Semiconductor

Jewellery

Solar panel

Optoelectronic

46
Pd
Palladium
106.42

49
In
Indium
114.818

31
Ga
Gallium
69.723

Workshop

First please follow our instruction on the shared screen
And then enter the Miro link shared in the chat!

Discussion

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